PATENT
Atty. Dkt. No. YOR920030431US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Hamann, et al.

Serial No.: 10/686,216 — Group Art Unit: 2883

Confirmation No.: 5867

Examiner: James P. Hughes

Filed: October 15, 2003

For: METHOD AND APPARATUS FOR FORMING LATERAL ELECTRICAL CONTACTS FOR PHOTONIC CRYSTAL DEVICES

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

APPEAL BRIEF

Appellants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 2883 dated June 9, 2006, finally rejecting claims 1-36. Please charge the fee of $500.00 for filing this brief and all other fees that may be required to make this Brief timely and acceptable to the Patent Office, including any extension of time fee, to Deposit Account No. 50-0510/YOR920030431US1.

REAL PARTY IN INTEREST

The real party in interest is International Business Machines Corporation, located in Armonk, New York.

RELATED APPEALS AND INTERFERENCES

An appeal is currently pending in United States Patent Application Serial No. 11/122,152, which is a continuation-in-part of the present application. A notice of appeal was filed in the 11/122,152 application on September 12, 2006.

STATUS OF CLAIMS

Claims 1-36 are pending in the application. Claims 1-36 were originally presented in the application. Claims 1-36 stand rejected in view of several references as discussed below. The rejection of claims 1-36 based on the cited references is appealed. The pending claims are shown in the attached Appendix.

STATUS OF AMENDMENTS

No amendments were made to claims 1-36 subsequent the Final Office action dated June 9, 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides a method and apparatus for forming lateral electrical contacts for photonic crystal devices. In the embodiment of claim 1, an apparatus comprises a photonic crystal (100) having a layer (104) where light is guided or is confined and at least one lateral electrical contact (102a, 102b) coupled to the layer (104) of the photonic crystal (100). The lateral electrical contact(s) (102a, 102b) is/are positioned on the layer (104) to provide electrical control along substantially the entire length of the layer (104). (See Appellants' specification, paragraphs 0020, 0026; Figures 1, 2)

In the embodiment of claim 21, a method for applying electrical control to a photonic crystal structure comprises providing a photonic crystal (100) having a layer (104) where light is guided. At least one lateral electrical contact (102a, 102b) is coupled to the layer (104) of the photonic crystal (100). The lateral electrical contact(s) (102a, 102b) is/are positioned to provide electrical control along substantially the entire length of the layer (104). Voltage is then applied to the lateral electrical contact(s) (102a, 102b). (See Appellants' specification, paragraphs 0020, 0025, 0026; Figures 1-4, 11)

In the embodiment of claim 32, a method for thermo-optic control of a photonic crystal structure comprises providing a photonic crystal (100) that comprises: a substrate (104), a plurality of apertures (106) formed through the substrate (104), and a waveguide (108) formed through the plurality of apertures (106), substantially proximate to the middle of the substrate (104). A first lateral electrical contact (102a) is formed proximate to the waveguide (108). The first lateral electrical contact (102a) is optically isolated from the waveguide (108) by the plurality of the apertures (106). A second lateral electrical contact (102b) is also formed proximate to the waveguide (108). The second lateral electrical contact (102b) is optically isolated from the waveguide (108) by the plurality of the apertures (106). The first lateral electrical contact (102a) and the second lateral electrical contact (102b) are positioned to provide electrical control along substantially the entire length of the layer (104). The substrate (104) is then sequentially heated and cooled. (See Appellants' specification, paragraphs 0020, 0025, 0026, 0029; Figures 1-4, 11)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1 and 21 stand rejected under 35 U.S.C. §102(b) as being anticipated by the Shirane, et al. patent application (U.S. Patent Publication No. 2002/0146196, published on October 10, 2002, hereinafter referred to as "Shirane"), or, alternatively, under 35 U.S.C. §103(a) as being obvious over Shirane.

Claims 1-15 and 21-31 stand rejected under 35 U.S.C. §103(a) as being obvious over Shirane.

Claims 16-20 stand rejected under 35 U.S.C. §103(a) as being obvious over Shirane in view of the Baba et al. patent (U.S. Patent No. 6,522,448, issued on February 18, 2003, hereinafter referred to as "Baba").

Claims 32-36 stand rejected under 35 U.S.C. §103(a) as being obvious over Shirane in view of the Montgomery et al. patent (U.S. Patent No. 6,845,198, issued on January 18, 2005, hereinafter referred to as "Montgomery").

Claims 1-36 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-19 of co-pending U.S. patent application no. 10/755,816 and claims 1-19 of co-pending U.S. patent application no. 11/122,152.

ARGUMENT

A. 35 U.S.C. §102b/103(a) – Shirane

1. Claims 1 and 21

The Examiner has rejected claims 1 and 21 under 35 U.S.C. § 102(b) as being anticipated by Shirane, or, alternatively, under 35 U.S.C. §103(a) as being obvious over Shirane. Appellants respectfully traverse the rejection

Shirane teaches an optical switch having a photonic crystal structure. In particular, the switch includes a core photonic crystal layer sandwiched between two layers of dielectric material. The photonic crystal layer includes a line-defect optical waveguide. An n-type region is formed adjacent to a portion of one side of the line-defect waveguide, while a p-type region is formed adjacent to a portion of the opposite side of the line defect region. The n-type region includes an n-type ohmic electrode, while the p-type region includes a p-type ohmic electrode.

The Board's attention is respectfully directed to the fact that Shirane fails to teach, show or suggest the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a waveguide, as positively claimed by Appellants' independent claims 1 and 21. Specifically, Appellants' independent claims 1 and 21 recite:

> 1. An apparatus comprising:
> a photonic crystal having a layer where light is guided or is confined; and
> at least one lateral electrical contact coupled to said layer of the photonic crystal, said at least one lateral electrical contact positioned to provide electrical control along substantially an entire length of said layer. (Emphasis added)

21. A method for applying electrical control to a photonic crystal structure comprising:

providing a photonic crystal having a layer where light is guided;

coupling at least one lateral electrical contact to said layer of the photonic crystal, said at least one lateral electrical contact positioned to provide electrical control along substantially an entire length of said layer; and

applying a voltage to the at least one lateral electrical contact. (Emphasis added)

In one embodiment, Appellants' invention is a photonic crystal structure including a substrate having a plurality of rows of apertures formed therethrough (creating a lattice) and a waveguide (where incident light is guided or confined) formed through the lattice (*e.g.*, by removing one or more rows of apertures). The photonic crystal structure further includes a pair of lateral electrical contacts, each contact being positioned laterally relative to one side of the waveguide and spaced a distance away from the waveguide by at least one row of apertures that optically isolates the contact from the waveguide. The contacts each extend along substantially the entire length of the waveguide, thereby providing a means for electrical control along the entire length of the waveguide. By applying voltages to the contacts, effects such as thermo-optic control of the waveguide, current injection and other photonic crystal applications can be achieved. (See Appellants' specification, paragraphs [0020-0026])

By contrast, Shirane provides only regional electrical control of the waveguide. That is, as best as can be understood from Shirane's disclosure and Figures (*i.e.*, Figures 11 and 12), the n- and p-type ohmic electrodes are positioned to provide current only along localized portions of the line-defect optical waveguide. The photonic crystal device claimed by the Appellants provides superior electrical control of a photonic crystal waveguide by positioning lateral electrical contacts along substantially the entire length of the waveguide, thereby achieving more consistent thermo-optic control along the length of the waveguide. The consistency of such an approach is preferable for applications such as photodetection, high-frequency switching and optical modulation, among others. Shirane does not teach, show or suggest positioning lateral electrical contacts along the sides of a photonic crystal waveguide in such a way as to provide electrical control over substantially the entire length of the waveguide, as claimed by the Appellants in independent claims 1 and 21.

The Examiner states in pages 3-4 of the Final Office Action that "[t]he applicability of 35 U.S.C. § 102 or 103 depends on the interpretation of the claim's recitation of 'at least one electrical contact positioned to provide electrical control along substantially **an** entire length of said layer.' (emphasis added) The electrodes of Shirane are taught to provide electrical control along **an** entire length – i.e., the entire length of the electrodes – of the waveguide layer. " The Appellants respectfully disagree.

The Appellants submit that the phrase "....along substantially an entire length of said layer" (emphasis added), as recited in claims 1 and 21, clearly refers to the length (i.e., lateral dimension) of the layer, and not the length of the lateral electrical contact or any other item disposed on the layer. That is, the Appellants submit that the structure recited in the claims requires the lateral electrical contact to be positioned such that the contact extends along substantially the entire length of the layer to which the contact is coupled (*i.e.*, the layer where light is guided or confined). The Appellants further submit that the claim could alternatively have been worded to recite a contact that extends "along substantially the entire length of said layer"; however, the current wording was chosen to avoid potential confusion due to antecedent basis issues. Thus, because claims 1 and 21 clearly require that the contact be positioned to provide electrical control along substantially the entire length of the waveguide layer, the Appellants submit that claims 1 and 21 are not anticipated by Shirane under 35 U.S.C. § 102.

The Examiner alternatively alleges that if the claims are interpreted as requiring the electrodes to extend along the entire waveguide layer, as urged by the Appellants, then a 35 U.S.C. § 103 rejection is appropriate. Although the Examiner concedes that "Shirane does not explicitly recite that the electrodes are positioned substantially along the entire length of the waveguide layer" (Final Office Action, p. 4), the Examiner also submits that "[i]t would have been obvious to one of ordinary skill in the art at the time of the invention to extend at least one electrode to cover the entire length of the waveguide ... because this would allow a larger region of the waveguide to be switched on/off" (Final Office Action, p. 4). The Appellants respectfully disagree.

Primarily, the Appellants submit that Shirane does not provide any motivation or suggestion to extend the electrode(s), as the Examiner suggests. Nowhere in Shirane is it taught or suggested that it would be desirable to modify the electrodes to provide electrical control along the entire length of the waveguide. Moreover, the portion of Shirane that is specifically cited by the Examiner to provide the motivation for such modification (*i.e.*, paragraph [0072]) at most simply states that it is possible to prevent light from propagating through the line-defect waveguide when a current or reverse bias voltage is applied between the electrodes:

> When current is injected or a reverse bias voltage is applied between the electrodes 80 and 81, the photonic band structure of the photonic crystal around the line-defect optical waveguide changes, by which the propagation mode of the line-defect waveguide becomes to be outside the photonic band gap, whereby light can no longer propagate through the line-defect waveguide. (Shirane, paragraph [0072], Emphasis added)

The cited paragraph, like the remainder of Shirane, makes no mention, either explicit or implicit, of the need to extend the lengths of the electrodes to provide electrical control along the entire length of the waveguide. Thus, this paragraph does not motivate such a modification.

Moreover, the problems that Shirane sought to address (*e.g.*, the low operating speed of conventional optical switches and the large size of conventional multi-channel optical switches) differ from the problems addressed by the present invention (*e.g.*, optical field distortion and absorption of light in photonic crystal devices). According to paragraph [0072] of Shirane, the structure taught by Shirane achieves all of the goals (either presented or contemplated) of the invention described therein. In other words, Shirane does not disclose or suggest that the stated goal of preventing the propagation of light through the waveguide is in any way tied to the lengths of the electrodes. More specifically, Shirane does not disclose or suggest that the stated goals of the invention can be better achieved by increasing the lengths of the electrodes or the lateral positioning of the electrodes. Thus, the Appellants respectfully submit that the Examiner is using the Appellants' claims as motivation or suggestion for the rejection under 35 U.S.C. §103. It is impermissible to use the advantages achieved by the present invention and hindsight to support the obviousness rejection.

As mentioned above, the Appellants' specification states that the electrical contacts are sized and placed in a manner to ensure minimal absorption losses, even when the contacts are formed from a metal or other material that would normally result in high absorption losses. The deployment of lateral contacts as claimed by the Appellants is a significant advancement over existing photonic crystal designs, as it allows for electrical control over the photonic crystal device with minimal absorption of light by the contacts. Notably, Shirane does not provide any suggestion or motivation to achieve this advantage offered by the present invention. Rather, Shirane only addresses a manner by which the propagation of light through a waveguide may be prevented. Therefore, the Appellants respectfully submit that claims 1 and 21 are not made obvious by Shirane under 35 U.S.C. §103.

Accordingly, the Appellants respectfully submit that independent claims 1 and 21 are neither anticipated nor made obvious by Shirane. As such, the Appellants respectfully submit that claims 1 and 21 are clearly patentable under the provisions of 35 U.S.C. §102 and 35 U.S.C. §103.

It should be noted that claims 1 and 21 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 1 and 21 recite different limitations and should be evaluated separately for patentability.

B. 35 U.S.C. §103(a) – Shirane

1. Claims 1 and 21

The Examiner has rejected claims 1 and 21 under 35 U.S.C. §103(a) as being obvious over Shirane. Appellants respectfully traverse the rejection

As discussed above with respect to the rejection under §102(b)/ §103(a), Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide, as recited in Appellants' independent claims 1 and 21.

Accordingly, the Appellants respectfully submit that independent claims 1 and 21 are not made obvious by Shirane. As such, the Appellants respectfully submit that claims 1 and 21 are clearly patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 1 and 21 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 1 and 21 recite different limitations and should be evaluated separately for patentability.

2. Claims 2 and 22

The Examiner has rejected claims 2 and 22 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 2 and 22 are also not rendered obvious, since claims 2 and 22 depend directly from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 2 and 22 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal is a two-dimensional structure comprising a substrate, a plurality of apertures formed through the substrate, and a waveguide for guiding the light, wherein the waveguide is formed in the light-guiding layer and is positioned proximate to the plurality of apertures, as set forth in claims 2 and 22. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 2 and 22 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 2 and 22 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 2 and 22 recite different limitations and should be evaluated separately for patentability.

3. Claim 3

The Examiner has rejected claim 3 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 3 is also not rendered obvious, since claim 3 depends directly from claim 1 and recites additional features of the present invention. Thus, claim 3 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-confining layer in a photonic crystal structure, where the photonic crystal is a three-dimensional structure comprising a plurality of high refractive index elements, a plurality of low refractive index elements distributed throughout the high refractive index elements, and a region located within the photonic crystal where the light is confined, as set forth in claim 3. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 3 is patentable under the provisions of 35 U.S.C. §103.

4. Claims 4 and 23

The Examiner has rejected claims 4 and 23 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 4 and 23 are also not rendered obvious, since claims 4 and 23 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 4 and 23 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure includes a first lateral electrical contact positioned proximate to a waveguide, the first lateral electrical contact being optically isolated from the waveguide by a plurality of apertures, and a second lateral electrical contact positioned proximate to the waveguide, the second lateral electrical contact also being optically isolated from the waveguide by a plurality of apertures, as set forth in claims 4 and 23. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 4 and 23 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 4 and 23 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 4 and 23 recite different limitations and should be evaluated separately for patentability.

5. Claim 5

The Examiner has rejected claim 5 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 5 is also not rendered obvious, since claim 5 depends from claim 1 and recites additional features of the present invention. Thus, claim 5 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-confining layer in a photonic crystal structure, where the lateral electrical contacts are metallic, as set forth in claim 5. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 5 is patentable under the provisions of 35 U.S.C. §103.

6. Claims 6 and 24

The Examiner has rejected claims 6 and 24 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 6 and 24 are also not rendered obvious, since claims 6 and 24 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 6 and 24 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where at least a portion of each of the lateral electrical contacts is doped, as set forth in claims 6 and 24. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 6 and 24 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 6 and 24 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 6 and 24 recite different limitations and should be evaluated separately for patentability.

7. Claims 7 and 25

The Examiner has rejected claims 7 and 25 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 7 and 25 are also not rendered obvious, since claims 7 and 25 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 7 and 25 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the lateral electrical contacts are substantially identically doped, as set forth in claims 7 and 25. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 7 and 25 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 7 and 25 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 7 and 25 recite different limitations and should be evaluated separately for patentability.

8. Claims 8 and 26

The Examiner has rejected claims 8 and 26 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 8 and 26 are also not rendered obvious, since claims 8 and 26 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 8 and 26 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the lateral electrical contacts are oppositely doped, as set forth in claims 8 and 26. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 8 and 26 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 8 and 26 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 8 and 26 recite different limitations and should be evaluated separately for patentability.

9. Claim 9

The Examiner has rejected claim 9 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 9 is also not rendered obvious, since claim 9 depends from claim 1 and recites additional features of the present invention. Thus, claim 9 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-confining layer in a photonic crystal structure, where one lateral contact is p-doped and the other lateral contact is n-doped, as set forth in claim 9. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 9 is patentable under the provisions of 35 U.S.C. §103.

10. Claims 10 and 29

The Examiner has rejected claims 10 and 29 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 10 and 29 are also not rendered obvious, since claims 10 and 29 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 10 and 29 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure includes a waveguide formed as a channel through a plurality of apertures, as set forth in claims 10 and 29. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 10 and 29 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 10 and 29 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 10 and 29 recite different limitations and should be evaluated separately for patentability.

11. Claims 11 and 30

The Examiner has rejected claims 11 and 30 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 11 and 30 are also not rendered obvious, since claims 11 and 30 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 11 and 30 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure includes a waveguide formed as a cavity disposed substantially in the center of a plurality of apertures, as set forth in claims 11 and 30. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 11 and 30 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 11 and 30 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 11 and 30 recite different limitations and should be evaluated separately for patentability.

12. Claim 12

The Examiner has rejected claim 12 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 12 is also not rendered obvious, since claim 12 depends from claim 1 and recites additional features of the present invention. Thus, claim 12 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a waveguide in a photonic crystal structure, where a substrate in which the waveguide is formed is doped in the region of the waveguide, as set forth in claim 12. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 12 is patentable under the provisions of 35 U.S.C. §103.

13. Claim 13

The Examiner has rejected claim 13 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 13 is also not rendered obvious, since claim 13 depends from claim 1 and recites additional features of the present invention. Thus, claim 13 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a waveguide in a photonic crystal structure, where a substrate in which the waveguide is formed is itself formed from a material having a high refractive index relative to the refractive index of a plurality of apertures formed therethrough, as set forth in claim 13. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 13 is patentable under the provisions of 35 U.S.C. §103.

14. Claim 14

The Examiner has rejected claim 14 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 1. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, dependent claim 14 is also not rendered obvious, since claim 14 depends from claim 1 and recites additional features of the present invention. Thus, claim 14 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a waveguide in a photonic crystal structure, where a substrate in which the waveguide is formed is itself formed from at least one of: silicon, carbon, germanium, gallium arsenide, gallium phosphide, indium phosphide, indium arsenide, indium antimonide, zinc oxide, zinc sulfide, cadmium sulfide, cadmium selenide, cadmium tellurium, and alloys thereof, as set forth in claim 14. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 14 is patentable under the provisions of 35 U.S.C. §103.

15. Claims 15 and 31

The Examiner has rejected claims 15 and 31 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claims 1 and 21. Since Shirane does not render obvious the

Appellants' invention as recited in Appellants' independent claims 1 and 21, dependent claims 15 and 31 are also not rendered obvious, since claims 15 and 31 depend from claims 1 and 21, respectively, and recite additional features of the present invention. Thus, claims 15 and 31 should be deemed patentable for at least the reasons stated above with respect to independent claims 1 and 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where apertures are formed through at least one of the lateral electrical contacts, as set forth in claims 15 and 31. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claims 15 and 31 are patentable under the provisions of 35 U.S.C. §103.

It should be noted that claims 15 and 31 are presented together only for the purpose of avoiding the need to present the arguments in two separate repetitive sections in this Appeal Brief. It is respectfully submitted that claims 15 and 31 recite different limitations and should be evaluated separately for patentability.

16. Claim 27

The Examiner has rejected claim 27 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 21, dependent claim 27 is also not rendered obvious, since claim 27 depends from claim 21, and recites additional features of the present invention. Thus, claim 27 should be deemed patentable for at least the reasons stated above with respect to independent claim 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, and applying a voltage over the first and second lateral electrical contacts by applying a forward bias to the contacts, as set forth in claim 27. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 27 is patentable under the provisions of 35 U.S.C. §103.

17. Claim 28

The Examiner has rejected claim 28 under 35 U.S.C. § 103 as being obvious over Shirane. Appellants respectfully traverse the rejection.

The Appellants submit that Shirane does not teach, show, or suggest all of the limitations of independent claim 21. Since Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 21, dependent claim 28 is also not rendered obvious, since claim 28 depends from claim 21, and recites additional features of the present invention. Thus, claim 28 should be deemed patentable for at least the reasons stated above with respect to independent claim 21.

Secondly, the Appellants contend that Shirane does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, and applying a voltage over the first and second lateral electrical contacts by applying a reverse bias to the contacts, as set forth in claim 28. This aspect of Appellants' invention is not disclosed by Shirane. Thus, the Appellants respectfully submit that claim 28 is patentable under the provisions of 35 U.S.C. §103.

C. 35 U.S.C. §103(a) – Shirane in view of Baba

1. Claim 16

The Examiner has rejected claim 16 under 35 U.S.C. § 103 as being obvious over Shirane in view of Baba. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Baba does not teach, show, or suggest all of the limitations of independent claim 1. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Baba does not bridge this gap in the teachings of Shirane. Namely, Baba also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure. Thus, dependent claim 16 is also not rendered obvious, since claim 16 depends from claim 1 and recites additional features of the present invention. Thus, claim 16 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane in view of Baba does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure is an optical delay line, as set forth in claim 16. This aspect of Appellants' invention is not disclosed by Shirane or Baba. Thus, the Appellants respectfully submit that claim 16 is patentable under the provisions of 35 U.S.C. §103.

2. Claim 17

The Examiner has rejected claim 17 under 35 U.S.C. § 103 as being obvious over Shirane in view of Baba. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Baba does not teach, show, or suggest all of the limitations of independent claim 1. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Baba does not bridge this gap in the teachings of Shirane. Namely, Baba also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure. Thus, dependent claim 17 is also not rendered obvious, since claim 17 depends from claim 1 and recites additional features of the present invention. Thus, claim 17 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane in view of Baba does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure is an optical modulator, as set forth in claim 17. This aspect of Appellants' invention is not disclosed by Shirane or Baba. Thus, the Appellants respectfully submit that claim 17 is patentable under the provisions of 35 U.S.C. §103.

3. Claim 18

The Examiner has rejected claim 18 under 35 U.S.C. § 103 as being obvious over Shirane in view of Baba. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Baba does not teach, show, or suggest all of the limitations of independent claim 1. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Baba does not bridge this gap in the teachings of Shirane. Namely, Baba also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure. Thus, dependent claim 18 is also not rendered obvious, since claim 18 depends from claim 1 and recites additional features of the present invention. Thus, claim 18 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane in view of Baba does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure is a photodetector, as set forth in claim 18. This aspect of Appellants' invention is not disclosed by Shirane or Baba. Thus, the Appellants respectfully submit that claim 18 is patentable under the provisions of 35 U.S.C. §103.

4. Claim 19

The Examiner has rejected claim 19 under 35 U.S.C. § 103 as being obvious over Shirane in view of Baba. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Baba does not teach, show, or suggest all of the limitations of independent claim 1. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Baba does not bridge this gap in the teachings of Shirane. Namely, Baba also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure. Thus, dependent claim 19 is also not rendered obvious, since claim 19 depends from claim 1 and recites additional features of the present invention. Thus, claim 19 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane in view of Baba does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure is a thermo-optic switch, as set forth in claim 19. This aspect of Appellants' invention is not disclosed by Shirane or Baba. Thus, the Appellants respectfully submit that claim 19 is patentable under the provisions of 35 U.S.C. §103.

5. Claim 20

The Examiner has rejected claim 20 under 35 U.S.C. § 103 as being obvious over Shirane in view of Baba. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Baba does not teach, show, or suggest all of the limitations of independent claim 1. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 1, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Baba does not bridge this gap in the teachings of Shirane. Namely, Baba also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure. Thus, dependent claim 20 is also not rendered obvious, since claim 20 depends from claim 1 and recites additional features of the present invention. Thus, claim 20 should be deemed patentable for at least the reasons stated above with respect to independent claim 1.

Secondly, the Appellants contend that Shirane in view of Baba does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the photonic crystal structure is a free-carrier injection switch, as set forth in claim 20. This aspect of Appellants' invention is not disclosed by Shirane or Baba. Thus, the Appellants respectfully submit that claim 20 is patentable under the provisions of 35 U.S.C. §103.

D. 35 U.S.C. §103(a) – Shirane in view of Montgomery

1. Claim 32

The Examiner has rejected claim 32 under 35 U.S.C. § 103 as being obvious over Shirane in view of Montgomery. Appellants respectfully traverse the rejection.

As discussed above, Shirane fails to teach, show or suggest the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a waveguide, as positively claimed by Appellants' independent claim 32. Specifically, Appellants' independent claim 32 recites:

> 32. A method for thermo-optic control of a photonic crystal structure comprising:
>
> providing a photonic crystal comprising:
>
> a substrate;
>
> a plurality of apertures formed through the substrate; and
>
> a waveguide formed through the plurality of apertures, substantially proximate to the middle of the substrate;
>
> forming a first lateral electrical contact proximate to the waveguide, the first lateral electrical contact being optically isolated from the waveguide by the plurality of apertures;
>
> forming a second lateral electrical contact proximate to the waveguide, the second lateral electrical contact being optically isolated from the waveguide by the plurality of apertures, said first lateral electrical contact and said second lateral electrical contact being positioned to provide electrical control along substantially an entire length of said layer; and

sequentially heating and cooling the substrate. (Emphasis added)

As discussed above, Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide, as recited by claim 32. Montgomery fails to bridge this gap in the teachings of Shirane. Namely, Montgomery also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of the waveguide. Thus, the Appellants respectfully submit that claim 32 is patentable under the provisions of 35 U.S.C. §103.

2. Claim 33

The Examiner has rejected claim 33 under 35 U.S.C. § 103 as being obvious over Shirane in view of Montgomery. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Montgomery does not teach, show, or suggest all of the limitations of independent claim 32. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 32, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Montgomery does not bridge this gap in the teachings of Shirane. Namely, Montgomery also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of the waveguide. Thus, dependent claim 33 is also not rendered obvious, since claim 33 depends from claim 32 and recites additional features of the present invention. Thus, claim 33 should be deemed patentable for at least the reasons stated above with respect to independent claim 32.

Secondly, the Appellants contend that Shirane in view of Montgomery does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the lateral electrical contacts are formed by forming a dopant layer proximate to the first and second edges of a substrate and depositing a metal over the dopant layer, as set forth in claim 33. This aspect of Appellants' invention is not disclosed by Shirane or Montgomery. Thus, the Appellants respectfully submit that claim 33 is patentable under the provisions of 35 U.S.C. §103.

3. Claim 34

The Examiner has rejected claim 34 under 35 U.S.C. § 103 as being obvious over Shirane in view of Montgomery. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Montgomery does not teach, show, or suggest all of the limitations of independent claim 32. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 32, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Montgomery does not bridge this gap in the teachings of Shirane. Namely, Montgomery also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of the waveguide. Thus, dependent claim 34 is also not rendered obvious, since claim 34 depends from claim 32 and recites additional features of the present invention. Thus, claim 34 should be deemed patentable for at least the reasons stated above with respect to independent claim 32.

Secondly, the Appellants contend that Shirane in view of Montgomery does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where the lateral electrical contacts are formed by forming a dopant layer proximate to the first and second edges of a substrate and depositing a silicide contact over the dopant layer, as set forth in claim 34. This aspect of Appellants' invention is not disclosed by Shirane or Montgomery. Thus, the Appellants respectfully submit that claim 34 is patentable under the provisions of 35 U.S.C. §103.

4. Claim 35

The Examiner has rejected claim 35 under 35 U.S.C. § 103 as being obvious over Shirane in view of Montgomery. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Montgomery does not teach, show, or suggest all of the limitations of independent claim 32. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 32, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Montgomery does not bridge this gap in the teachings of Shirane. Namely, Montgomery also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of the waveguide. Thus, dependent claim 35 is also not rendered obvious, since claim 35 depends from claim 32 and recites additional features of the present invention. Thus, claim 35 should be deemed patentable for at least the reasons stated above with respect to independent claim 32.

Secondly, the Appellants contend that Shirane in view of Montgomery does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where a voltage is applied over the lateral electrical contacts in order to sequentially heat and cool a substrate, as set forth in claim 35. This aspect of Appellants' invention is not disclosed by Shirane or Montgomery. Thus, the Appellants respectfully submit that claim 35 is patentable under the provisions of 35 U.S.C. §103.

5. Claim 36

The Examiner has rejected claim 36 under 35 U.S.C. § 103 as being obvious over Shirane in view of Montgomery. Appellants respectfully traverse the rejection.

The Appellants submit that the combination of Shirane and Montgomery does not teach, show, or suggest all of the limitations of independent claim 32. As discussed above, Shirane does not render obvious the Appellants' invention as recited in Appellants' independent claim 32, because Shirane provides no motivation or suggestion to extend the electrodes (contacts), as the Examiner suggests, in order to provide electrical control along the substantially entire length of the waveguide. Montgomery does not bridge this gap in the teachings of Shirane. Namely, Montgomery also does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of the waveguide. Thus, dependent claim 36 is also not rendered obvious, since claim 36 depends from claim 32 and recites additional features of the present invention. Thus, claim 36 should be deemed patentable for at least the reasons stated above with respect to independent claim 32.

Secondly, the Appellants contend that Shirane in view of Montgomery does not teach the novel concept of positioning lateral electrical contacts to provide electrical control along substantially an entire length of a light-guiding layer in a photonic crystal structure, where apertures are formed through the lateral electrical contacts, as set forth in claim 36. This aspect of Appellants' invention is not disclosed by Shirane or Montgomery. Thus, the Appellants respectfully submit that claim 36 is patentable under the provisions of 35 U.S.C. §103.

E. Obviousness-type double patenting

Claims 1-36 stand provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-19 of co-pending Application no. 10/755,816 and over claims 1-19 of co-pending Application no. 11/122,152.

In response, the Appellants filed two (2) terminal disclaimers on September 6, 2006. Thus, the Appellants respectfully request that the rejection of claims 1-36 under the doctrine of obviousness-type double patenting be withdrawn.

CONCLUSION

For the reasons advanced above, Appellants respectfully urge that the rejections of claims 1-36 as being unpatentable under 35 U.S.C. §102 , under 35 U.S.C. §103 and under the doctrine of obviousness-type double patenting are improper. Reversal of the rejections in this appeal is respectfully requested. If necessary, please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-0510/YOR920030431US1, and please credit any excess fees to the above referenced deposit account.

Respectfully submitted,

November 10, 2006

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CLAIMS APPENDIX

1. (Previously Presented) An apparatus comprising:

a photonic crystal having a layer where light is guided or is confined; and

at least one lateral electrical contact coupled to said layer of the photonic crystal, said at least one lateral electrical contact positioned to provide electrical control along substantially an entire length of said layer.

2. (Original) The apparatus of claim 1, wherein the photonic crystal is a two-dimensional structure comprising:

a substrate;

a plurality of apertures formed through the substrate; and

a waveguide for guiding said light, wherein the waveguide is formed in said layer and is positioned proximate to the plurality of apertures.

3. (Original) The apparatus of claim 1, wherein the photonic crystal is a three-dimensional structure comprising:

a plurality of high refractive index elements;

a plurality of low refractive index elements distributed throughout the high refractive index elements; and

a region located within the photonic crystal where said light is confined.

4. (Original) The apparatus of claim 2, wherein the at least one lateral electrical contact comprises:

a first lateral electrical contact positioned proximate to the waveguide, where the first lateral electrical contact is optically isolated from the waveguide by the plurality of apertures; and

a second lateral electrical contact positioned proximate to the waveguide, where the second lateral electrical contact is optically isolated from the waveguide by the plurality of apertures.

5. (Original) The apparatus of claim 4, wherein the first and second lateral electrical contacts are metallic.

6. (Original) The apparatus of claim 5, wherein the first and second lateral electrical contacts have layers that are at least partially doped.

7. (Original) The apparatus of claim 6, wherein the first and second lateral electrical contacts are substantially identically doped.

8. (Original) The apparatus of claim 6, wherein the first and second lateral electrical contacts are oppositely doped.

9. (Original) The apparatus of claim 8, wherein the first lateral contact is p-doped and the second lateral contact is n-doped.

10. (Original) The apparatus of claim 2, wherein the waveguide is formed as a channel through the plurality of apertures.

11. (Original) The apparatus of claim 2, wherein the waveguide is formed as a cavity disposed substantially in the center of the plurality of apertures.

12. (Previously Presented) The apparatus of claim 2, wherein the substrate in a region of the waveguide is doped.

13. (Previously Presented) The apparatus of claim 2, wherein the substrate is formed from a material having a high refractive index relative to a refractive index of said plurality of apertures.

14. (Original) The apparatus of claim 2, wherein the substrate material comprises at least one of silicon, carbon, germanium, gallium arsenide, gallium phosphide, indium

phosphide, indium arsenide, indium antimonide, zinc oxide, zinc sulfide, cadmium sulfide, cadmium selenide, cadmium tellurium, and alloys thereof.

15. (Original) The apparatus of claim 4, wherein some of the plurality of apertures are formed through at least one of the first and second lateral electrical contacts.

16. (Original) The apparatus of claim 1, wherein the apparatus is an optical delay line.

17. (Original) The apparatus of claim 1, wherein the apparatus is an optical modulator.

18. (Original) The apparatus of claim 1, wherein the apparatus is a photodetector.

19. (Original) The apparatus of claim 1, wherein the apparatus is a thermo-optic switch.

20. (Original) The apparatus of claim 1, wherein the apparatus is a free-carrier injection switch.

21. (Previously Presented) A method for applying electrical control to a photonic crystal structure comprising:

providing a photonic crystal having a layer where light is guided;

coupling at least one lateral electrical contact to said layer of the photonic crystal, said at least one lateral electrical contact positioned to provide electrical control along substantially an entire length of said layer; and

applying a voltage to the at least one lateral electrical contact.

22. (Original) The method of claim 21, wherein the step of providing the photonic crystal comprises:

providing a substrate;

forming a plurality of apertures through the substrate; and

forming a waveguide for guiding said light, wherein the waveguide is formed in said layer and is positioned proximate to the plurality of apertures.

23. (Original) The method of claim 22, wherein the step of coupling at least one lateral electrical contact to said layer of the photonic crystal comprises:

placing a first lateral electrical contact proximate to the waveguide, where the first lateral electrical contact is substantially optically isolated from the waveguide by the plurality of apertures; and

placing a second lateral electrical contact proximate to the waveguide, where the second lateral electrical contact is substantially optically isolated from the waveguide by the plurality of apertures.

24. (Original) The method of claim 23, wherein the steps of placing the first and second lateral electrical contacts further comprises:

doping at least a portion of the first and second lateral electrical contacts.

25. (Original) The method of claim 24, wherein the first and second lateral electrical contacts are substantially identically doped.

26. (Original) The method of claim 24, wherein the first and second lateral electrical contacts are oppositely doped.

27. (Original) The method of claim 26, wherein the step of applying a voltage over the first and second lateral electrical contacts comprises:

applying a forward bias to the contacts.

28. (Original) The method of claim 26, wherein the step of applying a voltage over the first and second lateral electrical contacts comprises:

applying a reverse bias to the contacts.

29. (Original) The method of claim 22, wherein the step of forming a waveguide comprises:

forming the waveguide as a channel through the plurality of apertures.

30. (Original) The method of claim 22, wherein the step of forming a waveguide comprises:

forming the waveguide as a cavity disposed substantially in the center of the plurality of apertures.

31. (Original) The method of claim 23, wherein some of the plurality of apertures are formed through at least one of the first and second lateral electrical contacts.

32. (Previously Presented) A method for thermo-optic control of a photonic crystal structure comprising:

providing a photonic crystal comprising:

a substrate;

a plurality of apertures formed through the substrate; and

a waveguide formed through the plurality of apertures, substantially proximate to the middle of the substrate;

forming a first lateral electrical contact proximate to the waveguide, the first lateral electrical contact being optically isolated from the waveguide by the plurality of apertures;

forming a second lateral electrical contact proximate to the waveguide, the second lateral electrical contact being optically isolated from the waveguide by the plurality of apertures, said first lateral electrical contact and said second lateral electrical contact being positioned to provide electrical control along substantially an entire length of said layer; and

sequentially heating and cooling the substrate.

33. (Original) The method of claim 32, wherein the steps of forming the first and second lateral electrical contacts comprise:

forming a dopant layer proximate to the first and second edges of the substrate;

depositing a metal over the dopant layer.

34. (Original) The method of claim 32, wherein the steps of forming the first and second lateral electrical contacts comprise:

forming a dopant layer proximate to the first and second edges of the substrate;

depositing a silicide contact over the dopant layer.

35. (Original) The method of claim 32, wherein the step of sequentially heating and cooling the substrate comprises:

applying a voltage over the first and second lateral electrical contacts.

36. (Original) The method of claim 32, wherein some of the plurality of apertures are formed through the first and second lateral electrical contacts.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

1. Related Appeal

United States Patent Application Serial No.: 11/122,152
Filing date: May 4, 2005
Inventors: Hamann et al.
Examiner: James P. Hughes
Group Art Unit: 2883
Confirmation No.: 5075
Relation: continuation-in-part of the present application
Notice of appeal filed: September 12, 2006
Appeal status: pending